

Acid / Base Chemistry Ch 14

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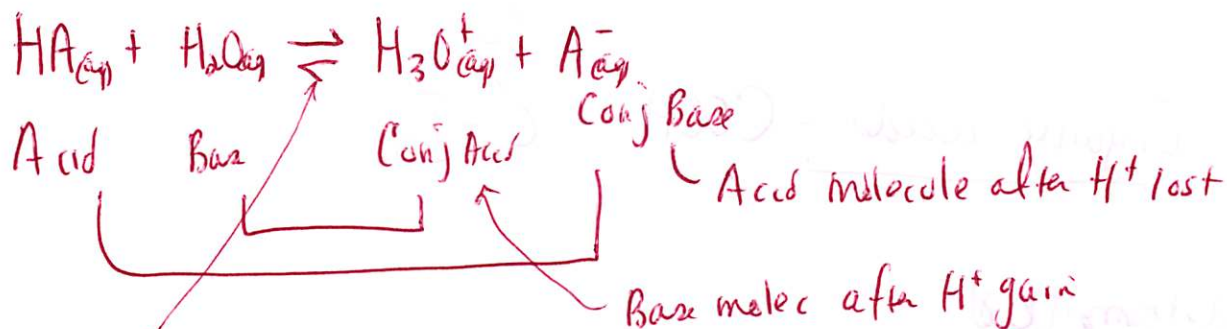
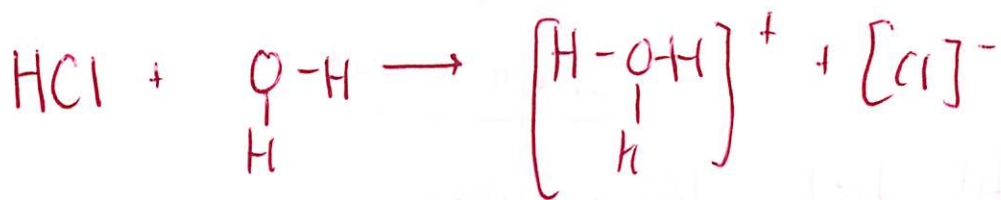
Define Acids

Arrhenius - Acids - produce H^+ ions
Bases - produce OH^- ions

} Based on work w/ electrolytes

limited only to aq solns.

Brønsted-Lowry - acid H^+ donor
base H^+ acceptor



→ Equilibrium direction depends on Base Strength of



$$K_a = \frac{[H^+][A^-]}{[HA]} \quad (H_2O \text{ omitted b/c it an } [] \text{ is constant})$$

Acid Strength

Strong Acid - K_a is large so E_q lies far to right
yields weak conj. base (low H^+ affinity)

HCl , $HClO_4$, H_2SO_4 , HNO_3 (can't calc K_a accurately)

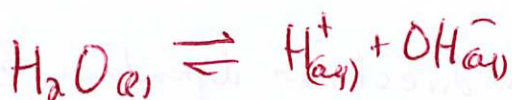
Weak acid - K_a is small E_q lies far to left.
weaker the acid stronger the conj base.

Diprotics - ~~more~~ 2 H^+ for H_2SO_4 \leftarrow 1st H^+ is 100% dissociated
2nd H^+ is not.
 H^+ lost 1 @ a time.

Organic acids - $COOH$ $\begin{matrix} / O / \\ / \\ C - \bar{O} - H \end{matrix}$

autonomous

Water as an Acid



$$@ 25.0^\circ C \quad [H^+] = [OH^-] = 1.0 \times 10^{-7} M$$

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$$

use to calculate pH

Review pH calculation

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$$\text{pH} = -\log[\text{H}^+] \quad \text{pH} + \text{pOH} = \text{p}K_w (14)$$

$$\text{pOH} = -\log[\text{OH}^-] \quad [\text{H}^+][\text{OH}^-] = K_w$$

(sig figs w/ logs \rightarrow # of decimals in log = # of sf in ^{second} ~~exp~~)

Do Problems

Simple pH of ^{strong} ~~acid~~ acids

pH of weak acids (E_9)

% dissociation calcs of WA

~~Other case~~

~~14.6~~ Percent Dissociation

$$\% = \frac{\text{amount dissociated}}{\text{initial } [\text{C}]} \times 100\%$$

$$\frac{[\text{H}^+]}{[\text{HA}]_0} \times 100\%$$

as acid is diluted % \uparrow
(numerator decreases)

But as HA is diluted $[\text{H}^+] \downarrow$ as $[\text{HA}]_0 \downarrow$, but % \uparrow

Bases

Strong Base - complete dissociation

Gr 1: Ca, Ba, Sr hydroxides are strong.

(May not be soluble but they are strong)

do similar pH calcs too

Brønsted-Lowry Bases too

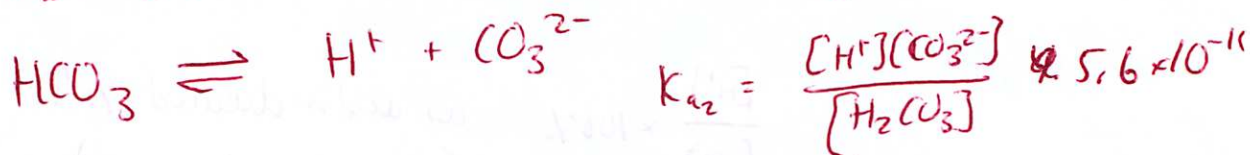
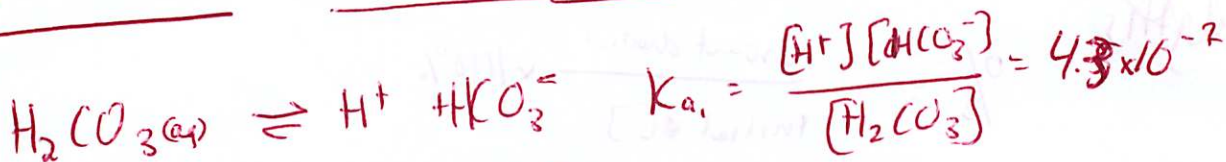
(Nitrogen's free e^- pair accepts H^+)



$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

table 14.3 shows K_b

Polyprotic Acids more than 1 H^+



$$K_{a1} > K_{a2} > K_{a3} \text{ etc}$$

when calculating pH only 1 H^+ used b/c 2nd subsequent are weak

for Sulfuric acid must do 2 calcs if low []

(3)

14.8 Acid-Base Salts

Salts of ~~or~~ Strong Acid make neutral solns

Salts of WA \rightarrow Basic Solns



$$K_b = \frac{[\text{HOAc}][\text{OH}^-]}{[\text{OAc}^-]}$$

$$K_{a_{\text{HC}_2\text{H}_3\text{O}_2}} = 1.8 \times 10^{-5} = \frac{[\text{H}^+][\text{OAc}^-]}{[\text{HOAc}]}$$

Find K_b value from K_a

$$K_a \times K_b = K_w$$
$$\frac{[\text{H}^+][\text{OAc}^-]}{[\text{HOAc}]} \times \frac{[\text{HOAc}][\text{OH}^-]}{[\text{OAc}^-]} = [\text{H}^+][\text{OH}^-]$$

Thus $K_a \times K_b = K_w$

$$\text{For } \text{OAc}^- \quad K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-5}} = \boxed{5.6 \times 10^{-10}}$$

\uparrow
low?

B/c OAc^- competing w/ OH^-

For H^+ & H_2O



Salts as weak acids

↳ Conj Acids of weak Bases $\rightarrow \text{NH}_4^+$

For NH_4^+Cl



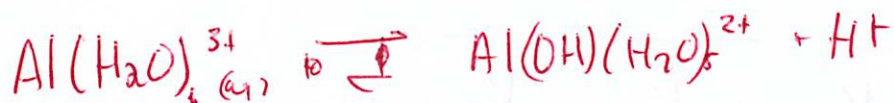
$$K_a = \frac{[\text{NH}_3][\text{H}^+]}{[\text{NH}_4^+]}$$

$$K_b \text{ NH}_3 = 1.8 \times 10^{-5}$$

$$K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

↳ Directly then K_w so NH_4^+ Break!

Also highly charged metal Cation
 Fe^{3+} , Al^{3+}



14.9 Structure on Acids Bases

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Any compound w/ H^+ is ~~not~~ potentially acidic



C-H bond non polar so no H^+ given off

But $H-Cl$ very polar so H^+ is given off.

2 Factors that lead to H^+ dissociation

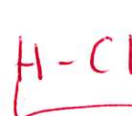
Bond Strength

Bond Polarity

Most Pol



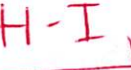
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Least Pol



Weak acid

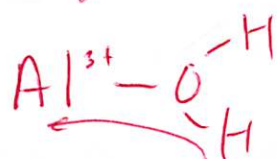
Strong

B/c Bond Energy too High b/c short Bond/strong Bond.

oxy acids - acid strength increases w/ ~~and~~ O H

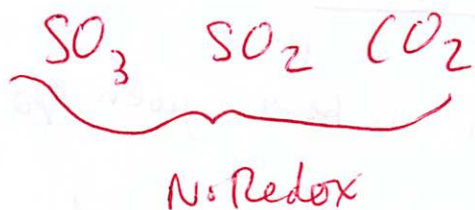
B/c O's Pull e^- away from Cl atom + O-H Bond.

Same for hydrated metal ions



Last \rightarrow $\begin{matrix} \text{H}-\text{O}-\text{Cl} \\ \text{H}-\text{O}-\text{Br} \end{matrix}$) Cl more e- neg
so stronger.

14.10 Acid anhydrides



Basic anhydrides



14.11 Lewis Acid / Base

LA - e^- pair acceptor

LB - e^- pair donor

Draw examples w/ $\text{NH}_3 + \text{H}^+$

